D6.3a: Acceptability of a home companion robot

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Project no:	**287624**
Project acronym:	**ACCOMPANY**
Project title:	**Acceptable robotiCs COMPanions for AgeiNg Years**

Doc. Status: Draft (Part A)
Doc. Nature: Report
Version: 1.1
Actual date of delivery: 25 November 2013
Contractual date of delivery: Month 24
Project start date: 01/10/2011
Project duration: 36 months
Internal Review: MADoPA

DOCUMENT HISTORY

Version	Date	Status	Changes	Author(s)
1.1	**2013-11-18**	**First version delivered**		**Jorge Gallego Pérez** **Manja Lohse** **Vanessa Evers**

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1 Summary

The present document serves as a first installment of deliverable D6.3 “Acceptability of a home companion robot”. The results of a study carried out at University of Twente are shown, intended to serve as preliminary study on long-term acceptance of robots by elderly people. That study was not long-term per se, rather it was intended to provide valuable guidelines for the next study. After reporting that study, the design of another, long-term study is provided. This long-term study will be the core of Task T6.2 “Identify the factors that strongly influence long-term user acceptance” and will be carried out alone by University of Twente until February 2014 (see Section 4.5: Time plan). After this, a second iteration will be performed by University of Twente together with UNISI.

2 Introduction

Two studies are included in the present document. The first study (see Section 3: Preliminary study) focused on the use of a robot to motivate elderly people to participate more in social and common activities. Interviews and sessions including exposure of the participants to the robot served to gain insight into their attitudes toward assistive robots that might some day stay in our own homes.

Subsequently, a study is proposed whose goal is the long-term assessment of user attitudes and responses toward a therapy robot that offers psychological re-enablement. To this end, we propose to carry out an exploratory study, consisting in a long-term (4 weeks) evaluation of people’s responses to a robot in their home. The robot will offer psychological re-enablement by doing Heart Rate Variability (HRV) exercises to reduce stress and depression. Due to the exploratory nature of the study and its ecological approach, we will greatly rely on methodologies based on qualitative data and analysis, such as interviewing and diary keeping. This study will serve as first feedback for deliverable D6.3 “Acceptability of a home companion robot” as it will study the long-term acceptance of users.

3 Preliminary study

3.1 Introduction

The aim of this preliminary pilot study is to explore meaningful exercises for a robot and elderly person to carry out together in the context of re-enablement and to explore the ways in which a robotic research platform can be deployed in a home for long-term acceptance research.

Lately, a lot of research has been reported on the use of robots for elderly. This research ranges from motivating elderly people to exercise [1], to keep people company [2] or to remind them to take their medicine [3].

This study consisted of three design stages with two user tests in between. The first design stage involved a literature research about the needs and interests of elderly people, different motivational strategies that motivate elderly people and the effect that robot interaction and robot's fysical design have on (elderly) people.

The Accompany project concerns independently living elderly. The current exploration involved elderly people who live semi-independently. The participants lived in their own apartment near or as part of a facility where they can meet others and if they wish, eat and participate in joint activities. The focus of the explorative study was to find a meaningful exercise in re-enablement and explore how to research the way people respond to robots as preparation for the long-term experiment. We were particularly interested in the support of elderly peoples' participation in social events.

Research questions

There were two main research questions that inspired our explorative study:

- How do people respond to robots in their home setting?
- What can we learn about deploying a robot in the home to inform our long-term studies to be carried out as part of D6.3?

3.2 Related work

In this section we discuss existing theory on motivation and the effect of social participation on elderly people's lives. We will also describe relevant previous work.

Vallerand and O'Connor [4] describe a framework for motivation in every day behaviour of elderly people. They mention four types of motivation types: Intrinsic, extrinsic (self-determined), extrinsic (non-self-determined) and amotivation. Intrinsic motivation is doing things because they are worthwhile in themselves, without a reward. Self-determined extrinsic motivation is doing something because of a self-determined reward: for example, playing brain gym because you believe it will make you healthier. Non-self-determined extrinsic motivation is when the reward comes from someone else. Amotivation is when you feel an activity has no extrinsic or intrinsic value.

Kwan and Bryan [5] present a study that tested whether affective response to exercise leads to greater motivation in terms of attitudes, subjective norms, self-efficacy and intentions to exercise. They found

that people who feel good during exercise have more positive attitudes to exercise even three months later. They also have more intention to exercise again. The Apathy Evaluation Scale is a method of rating a person's feelings over the previous 4 weeks. According to Resnick et al. [6] this scale can also be used to be measure motivation in elderly people.

Fritsch et al. [7] carried out a study on the social isolation of elderly people. They found that the amount of social interaction people have decreases with age. 45% of the elderly people they interviewed said they wanted more direct social interaction, and 58% wanted a simpler way of finding contacts. One of their main conclusions was that there is a strong need for an online network that makes it simple for elderly people to contact each other.

Elderly people were not only found to want more social contacts, an active social life was found to have a lot of positive effects on people's health as well. Crooks et al. [8] did a study on the occurrence of dementia among older women. They found that people with a larger social network have better cognitive function and less dementia. Lack of social contact is even linked with self-neglect in elderly people. In this state, elderly people fail to or are unwilling to maintain their basic needs. According to Burnett et al. [9], there is a significant correlation between having a small or non-existing social network and self-neglect.

Fasola & Mataric [1] present a socially assistive robot that helps elderly people during exercising. It does so by monitoring the user and providing motivation for completing the exercise using speech. Three different types of exercise games were available: a workout game, an imitation game and a memory game. A survey was held to evaluate the usefulness of the robot as perceived by the participants. The robot was perceived to be more than moderately helpful.

Wada & Shibata [2] report a study where elderly people were given a small seal robot (named Paro) that acts as a companion. The robot looks like a small harp seal, has white fur and behaves similar to a real baby-seal. Their idea was inspired by the positive effects that animals are reported to have on the health and stress levels of elderly people in combination with the fact that animals are not allowed in most homes for elderly people. The robot was found to have a positive effect on elderly people: they communicated more with each other and had a better reaction of their primary organs to stress. Kidd et al. [10] also used the Paro robot in two nursing homes to measure whether robotic interactions generate more social activity. Based on their findings they conclude that Paro is certainly entertaining to many people and it gave people something to talk about with each other.

Looije et al. [3] focused their research on the question whether a socially intelligent robot is able to change the behaviour/lifestyle of a diabetic. For their experiment they used the iCat, a socially intelligent robot that is able to express emotions through facial expressions and speech. They created a list of guidelines for personal assistance and health devices and evaluated whether the application of these guidelines had any effects on user preferences. After incorporating the guidelines to the iCat, the authors found that the Icat was preferred to a text interface.

Pollack et. al [11] describe the design of a mobile robot assistant that helps elderly people remember routine activities such as eating, drinking and taking medicine, and also guides them through their home. Breazeal [12] highlights a few interesting implementations of social robots that can be used in healthcare applications. Finally, Hutson et al. [13] produced a set of requirements for social robots that help the elderly by reducing their loneliness and improving their mood.

In conclusion, we found that there is work available that suggests the adoption of robots to improve elderly people's social participation, affective state and health is possible. We could not find any studies that assessed the impact of robot assistants on elderly person's health over the longer-term. The studies by the paro robot are the most closely related and suggest indeed a long-term impact an elderly peoples' social engagement and affect, however Paro is very limited in its interaction behaviours and tested with elderly people that are not capable of independent living. The Paro robot serves as a comforting agent in this scenario.

3.3 The Giraff robot

In this section we describe the robot that we used to explore elderly people's responses to robots. The Accompany project revolves around the car-o-bot as developed by Fraunhofer. However, because the consortium has limited use of the robot, the UT is not one of the partners that can make use of the robot and because the car-o-bot can only be deployed in a very controlled setting for safety purposes we used a simple Giraff robot as a technological probe for this study.

The Giraff robot (Giraff Technologies AB), is originally a telepresence robot which was specifically developed in the context of elderly care (see Figure 1). The Giraff is based on existing telepresence technology that is normally used in global collaboration to attend meetings remotely. With Giraff, this technology is made to look a bit friendlier and simple. Its current deployment involves remote visits by professional and informal carers.

Figure 1: Giraff robot

The Giraff is similar to ACCOMPANY's robot, the Care-O-Bot 3, in several aspects. The Giraff is similar in size, 1.5 m high, and runs on wheels. As the Care-O-Bot 3, it is not humanoid in shape but presents a friendly design. However, Care-O-Bot 3 has an arm that allows it to interact with the environment, whereas the Giraff does not. Another difference is that the Giraff is designed for videoconferencing, including a screen that can show the face of the teleoperator. The Giraff is

controlled remotely through a WiFi network connection with software that allows the videoconferencing as well as the controlling of the movement of the robot and the volume of its speakers and microphone sensitivity. This software is fairly easy to use even by un-experienced users. The robot has two buttons, a green one for accepting calls and a red one for hanging up or refusing calls. It also has a volume knob. The Giraff can function for about an hour before needing to charge again. The Giraff is based on normal PC hardware, and runs Microsoft Windows 7.

3.4 Interviews

Interviews were held both with elderly people at the day activity facilities and with professional carers that work there. The interviews took place in retirement homes in both Gronau (Germany) and Enschede (The Netherlands). Interviewees were either residents in semi-independent units or full independent units where they sometimes joined the activities of the centre. Interviews were held with 14 residents in elderly homes, 9 in Gronau and 5 in Enschede. Interviews were held with 5 professionnal carers, 3 at the Gronau location and 2 at the location in Enschede. The main difference between the two locations is the language used for the interviews (German in Gronau and Dutch in Enschede) even though both locations are about 10 KM apart, the national border runs in between and in Gronau the elderly people that are resident or that spend time during the day-facilities of the elderly care centre are predominantly German, in Enschede they are predominantly Dutch. The interviews were held to get an impression of how elderly people may respond to robots in the home as part of a long-term study.

The interviews are divided into two main parts. The first part concerned the activities that elderly (do not) join, why they (do not) join them and how they are and can be motivated to join. One of the aims of this part of the interview is to get information about certain aspects that may influence the amount of participation in activities. Another aim was to gain information about reasons why elderly do not join social activities. A last aim was to get information about how to motivate elderly people.

The second part concerns the interaction with the robot. During this part of the interview, three scenarios were given. The first one introduced a professional carer caregiver that visits elderly people to ask them to join an activity. In the second and third scenario the professional carer is replaced by the Giraff robot, either as telepresence for the caregiver (with the caregiver on screen) or as a more autonomous robot (with an avatar on screen). The aim of this section of the interviews was to get information about the attitude of elderly and caregivers towards the idea of motivating elderly in this way and about using the Giraff. The full questionnaire can be found in Appendix A.

3.4.1 Results Interviews elderly

The most popular activities mentioned by elderly in Gronau were open days (which involve listening to music), walking together and playing bingo. In Enschede most popular were bingo and listening to music. Rather than talking about unpopular activities, the elderly started talking about why they could not join a particular activity. The two most important reasons why elderly do not participate in activities were physical impairments and whether they liked the particular activity. Furthermore, one resident in Enschede also mentioned that she had too many activities planned outside of the organised activities and another mentioned that she did not participate because she did not know a lot of people.

In Gronau one other reason mentioned was their habits: if people are used to being alone, then it's difficult to motivate them to join social activities

Participants both in Gronau and Enschede did not report to have a lot of experience motivating other elderly people they know. They mentioned that talking positively about a particular activity helps others to join, also because some people may have the wrong idea about what the activities entail. In Enschede, some participants mentioned motivating others by going to their home before the activity to pick them up and join together. One resident in Enschede mentioned that it is no use to motivate someone else, because everybody gets enough information about what activities can be done already, so if they wanted to join they would be there.

Interviewees mentioned not to have (much) experience with technology such as mobile phones and computers. In Gronau there were 3 residents with a mobile phone and in Enschede the interviewees were found to use a landline phone, a television and/or ceefax.

In general, the residents like the idea of a real person knocking on their door to ask them to join an activity. Only 2 of the interviewees in Gronau and 1 resident in Enschede did not like this scenario.

The idea of a robot to interact with was reasonably accepted. 4 of the residents in Gronau did not like the idea of interacting with a robot at all, while 2 liked it, leaving the other 3 on the fence. In Enschede 2 people did not like the idea, while 2 of them thought it would be an interesting experiment, leaving 1 person hesitant, because she could not imagine how this would work in reality. A reason why interviewees did not like the robot as mentioned in both locations is that they do not know or can imagine the robot, they would need to get used to it. In Enschede it was also mentioned that they did not like the idea because it sounded fake and impossible. In Gronau interviewees mentioned that it is not important who comes to ask them to join an activity, but the most important aspect is that it helps.

3.4.2 Evaluation interviews professionnals carers

Caregivers on both locations mentioned that there are a lot of elderly people that join activities. The caregivers in Gronau mentioned that there are groups of people that do activities together outside of the organized activities. From the interviews caregivers seemed to feel that there is no real relation between the extent to which elderly participate in activities and how many visitors they have, how much they communicate with others, and how lonely they are. In Gronau however caregivers mentioned that elderly people’s mood does play an important role in trying to motivate them to participate in activities. In Enschede it was mentioned that when elderly get a lot of visitors they may not feel the need so much to join organised social activities.

Listening to music is a very popular activity in both Gronau and Enschede. In Gronau family can visit during the music activities, which is an important factor to them for participating. Another popular activity in Gronau is sports, while in Enschede this is bingo. In both elderly homes there do not seem to be explicit unpopular activities, but activities that demand intellectual effort seem to be the least visited.

The caregivers in both locations mentioned many reasons why elderly usually do not join activities. The most important mentioned are the physical health of the elderly person, their personality, their habits and routines, the way the activity is presented to them and what they know about the activity.

Caregivers seem to differ on whether it is possible to motivate elderly people to be active. In Gronau caregivers felt they could, while in Enschede it was mentioned that this is only possible if the elderly really wants to him/herself. At both locations it was reported that elderly may feel better after thgey participate.

In Enschede an intake appointment is kept when a new person signs up and they are asked what activities they like and want to do. Often, new participants start slowly with only one activity at first. When an elderly person does not join activities, the staff sometimes will ask them why they do not join. In Gronau, caregivers felt motivating elderly people can be done by using keywords that are dependent on the person and by having an emotional report with the person. Also by making the activity attractive and use the motivating factor of having relatives join. This last factor was also mentioned in Enschede. Both homes mention that when motivating elderly, it is important not to be pushy.

The idea of a real person knocking on the door of the elderly to ask them to participate in an activity is accepted in both locations. The real advantage of this sceanrio is that it involves personal contact. A limitation is that it depends on the person whether this will work. Staff in Enschede mentioned that they already do this, but only with activities that elderly have signed up for. The notion of letting elderly people search for specific other people to join an activity is received differently in the homes. In Gronau they think it is obvious that this should be possible, but in Enschede they think that elderly will not use this ‘service’, because they will not start searching for others by themselves. Also, staff felt that residents prefer to see the same face every day.

The caregivers had more negative associations than positive associations with the idea of a robot motivating people to join activities. They think it will probably lead to loss of personal interactions and the elderly will probably not trust or like it. Furthermore they expect a lot of complications. For instance, they doubted if it would work, because someone may not be able to stand up by himself and the robot would be unable to help them get up. However, there were also some positive expectations. For instance, the staff felt they would certainly try it and they thought the robot could function as a reminder for activities. Overall, staff prefered the notion of a real person through telepresence on the robot compared with an autonomous robot. In fact, staff thought that elderly people would be uncomfortable with an autonomous robot facilitator to such an extent that we decided to start our exploration with robots as technological probes with the scenario of a telepresence robot. This was decided so that we were sure the leap from a caregiver to an autonomous robot would not be too large to be comprehended by the elderly participants.

3.5 Exploring deployment of a robot for elderly with a technology probe

In order to have a first exploration of how to deploy robot in the homes of elderly people, we exposed some of the participants related to the day activity centre to technological probe. The probe was a Giraff robot (see Figure 1). The Giraff robot had the possibility of being remote controlled by a remote staffmember (telepresence robot, the staff member’s face is visible on the Giraff screen) and the possibility of seeming autonomous. In the latter case the robot was still remote controlled by a researcher but the suggestion is created that the robot moves autonomously, also on the screen of the Giraff was displayed a minimalist graphical depiction of a face.

The avatar program runs on a remote laptop computer, and uses the Haptek player (Haptek Inc.) to render a minimalist 3D face. The Haptek player can also render a voice with lip sync by using a text to speech engine. The player runs inside an ActiveX control (only on Microsoft Internet Explorer) of a simple website. The avatar speech is controlled using javascript. Using the website, we can make the avatar say the lines of the script. To send the sound to the robot in the highest quality possible, we used a program called Stereo Mix Plus to capture the sound of the prototype and relay it to a virtual microphone. The avatar image is then captured using Manycam and sent, together with the sound, to the Giraff using the Giraff software (Giraff Pilot). This setup allows us to interact with a user through the avatar in a comfortable way (see Figure 3).

The prototype is fairly simple: it has a pre-set script for interaction. The robot (either telepresence or autonomous) starts by saying hi and asking the user how they feel. The robot then suggests an activity, and asks the user if they want to join. The robot closes the conversation by saying goodbye. The timing of the script is remote controlled through a laptop.

The Accompany project focuses on an autonomous robot in the home for independent living and re-enablement. Nevertheless, in this exploration we worked with the scenario of an autonomous facilitator as well as a telepresence facilitator. The reason for this was that in the interviews it became clear that the elderly persons had many difficulties with the notion of a fully autonomous robot. In fact, the staff thought that it may be too disturbing. Because of this reason we explored first with the notion of a staff member remote controlling the robot (telepresence) and followed this with the scenario of an autonomous robot facilitator. The differences in functionality between both robot-types were addressed in the study methodology. As much as possible was controlled to keep the experiences the same. In the telepresence situation, the robot was controlled by a staff member from the hallway. In the ‘autonomous’ condition the robot was controlled from a laptop by a researcher. This study is a first and low-fidelity exploration of evaluating how people respond to a robot in the home environment and is meant to inform our follow up studies where we intent to introduce a robot in elderly people’s home long-term. Therefore, the methods adopted for both functionalities were not fully structured and informal.

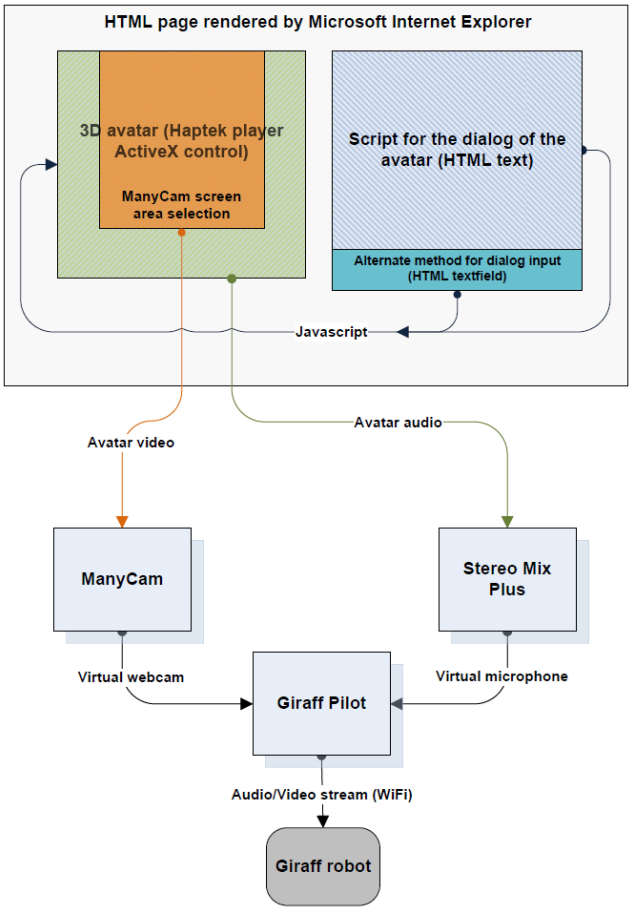

Figure 2: Schematic of the software components of the prototype

3.6 Exploration on Location in Gronau

The first probe assessment was carried out at the elderly activities facility in Gronau Westphalia in Germany that is close to the Dutch national border and to the city of Enschede in the Netherlands. In total ten persons participated in this study. Four of these participants could be categorised as Motivated Users (3 female and 1 male) and 4 could be identified as Less Motivated Users (all female). Also, two persons from staff participated. The participants were a subselection of the people who were involved for the earlier interviews.

Every participant was visited upon appointment. A Staff Member with Social Care diploma from the facility functioned as the remote staff member in the case that we explored with the telepresence robot scenario.

The study consisted of seven parts:

1. Researchers meet and greet the participant in their home

2. Prepare equipment, explaining the study and signing of consent form

3. Conversation with the social worker as a remote presence on the robot

4. First interview

5. Conversation with the ‘autonomous’ robot

6. Second interview

7. Thanking for participation and debriefing

The study was carried out in the homes of the elderly people. In order to get to the shared activities room, they needed to traverse their floor toward the communal section. The Giraff robot was placed directly opposite of where the elderly person was seated. The researcher who operated the Giraff robot on the laptop was sitting in an opposite corner of the room. In the telepresence scenario everything was kept in the same order. The only difference was that the laptop was brought into the hallway and placed on a table. The social worker would remote control the giraffe and talk to the elderly people through a laptop from the table in the hallway.

Two researchers were present during the experiment. When they entered the room, after greeting the elderly, the equipment and actions were prepared. One of the researchers mainly prepared the technical equipment of the robot. The other researcher informed the participant, prepared the laptop, the interview and a smartphone to record the whole experiment. This student also introduced the elderly to the goals of the study, gave the consent form to them and explained the procedure that would follow. During that time the robot was placed in front of the person. Soon the social worker would have a short conversation with the person through the robot. After this conversation, the first interview was given. Afterwards, the equipment and technical settings were changed for the second part of the experiment in which the robot would speak with the person with an avatar on screen. The conversation with the social worker through telepresence was personal and about a different aspect each time because the social worker had a personal rapport with each of the participants. The discussion with the robot revolved around joining social activities.

During the experiment in Gronau we learned how the robot probe performed, and what was missing or did not perform well. The prototype was changed to reflect these findings. We found that the script was not flexible enough to allow for the differences in responses the participants gave. One such occurrence was when the robot asked if they wanted to join the activity. If the test subject answered ‘maybe’, the script had no option for that. We changed that by adding the sentence ‘Then I hope I will see you at the activity’. Sometimes the test subjects would suggest an activity that they wanted to be organized in the future. The script had no option for that. Therefore, we added a sentence called `we will pass your suggestion on to the caregiver’. Because it’s a good idea to have residents suggest activities, we took this as inspiration and had the robot ask for suggestions for new activities, if the participants did not mention any. To add more flexibility to the prototype, we also added a free input box for text. This box allows the operator to send any sentence to the avatar, so that the robot can say it.

3.7 Preliminary Results from Exploration with robot as technological probe

The experiment including the transportation of the robot, the preparation of the equipment and conducting this experiment passed without having any bigger problems. Only two times problems with the connection of the Giraff network occurred which incomprehensibly showed a full network access. This could be fixed quickly after relocating the router and restarting the system. Additionally, the text

input of the avatar had to be changed during the experiment due to some confusion in the conversation content. Only one male participant took part in this study. An explanation that is likely for this is that male residents are in the minority and are also less motivated to join social activities in general.

In Enschede there were five participants, each of them had also participated in the interviews.

Due to time issues, the caregiver and volunteer did not get to test the Giraff completely. The caregiver used the Giraff software to talk to the participants through the Giraff, but she did not move the Giraff.

Telepresence robot probe vs autonomous robot probe

The interaction with the social worker as displayed on the robot's screen in both groups was experienced as quite good and clear. Participants mentioned finding it amusing and liked the interaction with the social worker on the screen. Some mentioned that they found the voice much better and more understandable than the autnoumous robot (N=2) or that they just like it very much although it was unusual (N=3). Two others smiled and said that "it was good" and one added that it was "as if she was standing next to her". Three mentioned they would accept it when the social worker visits them in this way, but pointed out this should happen only when there is no other possibility for the social worker to inform and assist them. Only one participant was totally opposed to the telepresence interaction, she would prefer the social worker in real life than on the screen. Another participant, thought that the conversation was "cold", despite liking the experience of the telepresence interaction. This statement was also given by another participant, saying that she would rather prefer to have a real conversation. It seemed to her "it was like a telephone call" and she would accept it in the case it is necessary to quickly inform someone about something important. With regard to coming into the room to suggest an activity and try to assist the person only two participants found it acceptable but stated that it only should happen sometimes and only if it is the only solution for it without replacing the social worker. Two other persons said that it can be used for future generations of elderly people who are already used to technical interactions. All participants agreed they would join the activity that was suggested to them by the social worker in the conversation. No further improvements were suggested but only the fact that the social worker looks much better on the screen than the avatar in the autonomous robot.

The appearance of the avatar on screen in the robot condition was generally accepted by all. Two people mentioned that it is "a nice girl" and another said that" there is nothing special about her". For two participants the appearance was perceived as a bit weird or unfriendly at first sight but changed into more friendly as the avatar started to speak. Three participants said that the first thought about the avatar was that it is "something new to talk to her", that it is "interesting and new but weird" and a "nice girl". Another said "Oooh how weird" adding "people have never seen that before" and "I am happy about the progress in technology". Another mentioned the same adding that it is "nice to see the progress in technology" although she pointing out that this kind of conversation seems to be nothing for her age. One participants who though it might be nice for generations to come, immediately pointed out that she has no interest in these kinds of technologies at all by saying "I must state quite clearly..I do not accept it". For two participants, the conversation and the robot were perceived as a bit stubborn due to the artificial speech. The voice itself was clear for every participant although it could have been more friendly, as one participant remarked.

The voice of the autonomous robot in Dutch (for the explorations done in Enschede) was a real limitation. Only 2 of the 5 participants could understand or hear it well enough to have a conversation.

The participants were not too enthusiastic about the robot coming by to ask them about activities. Finally, the 4 of them did say that they would not have a problem with the robot coming by if it was not too often (about once a week). However, the voice must be clear and understandable. Also, similarly to in Gronau, the participants see this visit more as a reminder of an activity they would already join than as an invite to a new activity, because they are already very busy. One of the 5 participants really did not want to have the robot come by her door. 3 of the participants could not really imagine how they would talk to the robot in the future. For the other 2, one of them could imagine herself talking to the robot, but not getting to know it. One said she would probably talk about particular subjects more if she would see the robot more often.

All the Dutch participants liked talking to the caregiver through the robot and even 2 of them thought it made no difference talking to the caregiver personally or through the robot. The other 3 however preferred talking to the caregiver in person. However, if the caregiver would not have time to come in person they would not mind talking through the robot.

The evaluation of the responses of the staff (social workers)

Only 2 social workers in Gronau were exposed to the robot and experienced talking with the 'autonomous' version and remote controlling the telepresence version. In general, they experienced controlling the robot as challenging. The reasons were mostly to do with the usability of the interface “I cannot adjust the tempo “and “it works much better with a mouse than a touch field". The situation of talking to someone through the robot was experienced as dubious (one staffmember) on the one hand but that something she could get used to on the other, because “it reminds me of a telephone call only that it is possible to see each other” (the other). Anyway the disadvantages reported were that it is difficult to talk because the use of their own nonverbal behaviour is missing. Also, recognizing the gestures and facial expressions of the person thal a social worker is talking to is missing because it is too far away to see it well. One of the social workers added that it is difficult to concentrate on the conversation because they are not used to it. Despite of the many disadvantages one social worker was pleasantly surprised about the robot with avatar and found it sympathetic even though she had been sceptical. Both social workers even pointed out that they could imagine the robot to be used for big halls in which the robot could go from table to table in order to inform everyone about meetings which would be very useful. Both social workers agreed that the interaction the robot had with the elderly should be a consideration for future generations of elderly who are more used to technology. They thought elderly might be curious about it, but “the people prefer social communication". However, in big facilities the technology was thought to be helpful if accepted by the people. Strongly accepted by both social workers was the aspect that the robot can be used to remind people of something. It should be used in short communications with elderly to assist them in different situations like asking how they feel, mentioning changes or informing them about new plans in the retirement compound.

At the Enschede location, the caregiver that had remotely operated the Giraff said she actually did not pay much attention to the elderly person on the screen, because she was too busy making sure that she herself could be seen on the webcam. The caregiver mentioned that using a robot in an elderly facility was something that still was beyond the imagination of the residents. Similarly the volunteer caregiver mentioned that she thought the participants had been positive of the idea because they could not really imagine it happening soon. The volunteer mentioned that she was afraid that people would think 'oh that is easy, now I do not have to walk to the elderly, but I can talk to them from a distance', while she feels that personal contact is very important. Also the caregiver mentioned that it the telepresence

robot was somehow a way to try to make it a bit personal while simultaneously taking away personal contact. The caregivers felt that the interaction with the 'autonomous' robot needed to be different, not only the voice which had been difficult to nderstand but also the appearance, they felt a more natural interaction would be essential.

3.8 Discussion and Conclusion

The goal of our project was to assess people's initial responses to a robot in the home. Also, we wanted to explore the challenges for running a long term study with a robot on location.

As a meaningful topic, we decided to focus on motivating elderly people to participate more in social and common activities. This decision was made based on relatd literature, in which we found that elderly people who are more social and active are healthier, more independent and have a higher quality of life than those who do not.

We investigated the responses of elderly people and the people who care for them. During the interviews we found that most residents were quite sceptical about the idea of a robot in the home or at the day-activities centre. Considering a robot that would actively seek them out and ask them to join an activity, the participants seemed open to the idea, but all had a strong preference for a real person coming to get them. The participants involved in the study were all at least affiliated with a care facility. We believe that therefore, they are more used to carepersonell visiting their homes and taking part in therapies and training or using care-technology. For the long-term experiments with independent living elderly, we expect less accustomisation to therapies and/or care facilities. Because of this we think the robot would be more scrutinized before acceptance or usage.

During the sessions where the participants were exposed to a robot probe either in telepresence or autonomous mode. The text to speech software that was used was hard to hear for some residents. As we found in previous studies [14], elderly people have a difficult time understanding robot voices. Whether this is because the unnatural sound of the digitally produced voice is unfamiliar, whether the amplification is difficult to hear when hearing deteriorates, whether important non-verbal cues are missing or whether the context of the conversation with the robot was so different from their usual conversations that the participants simply could not cope is unknown. It does seem that when a robot uses natural language to communicate with elderly people, especially when this is automatically generated, this is extremely challenging. The accompany project does not focus on natural language interaction and the trend that we notice in our studies is an indication to us to find non-verbal ways to interact with elderly users. For the long-term experiments therefore, we will not engage the use in spoken language interaction.

The interviewees had been negative about the idea of a robot coming to visit them. However, in the explorative study with the Giraff as technological probe, the same participants were more positive. Most could see the robot as a useful technology to go door to door and remind people who had signed up to come and participate in a certain activity. Our explanation for the more favourable attitude toward the real robot is that there were researchers present who prepared the robot technology, facilitated the interaction experience and held the post-session interviews. It seems not unlikely to us that the elderly people who were visited were positive toward these young researchers and were therefore favourable in their judgement of the robot. In previous studies also [15], [2], where favourable atttitudes and responses toward robots were found for elderly users, researchers had a very

active role in data collection. In a short term experiment, being present during the session and for longer-term studies visiting the participant often to collect data or debug the technology. Our assessment is that future studies should minimise the contact between researchers and the elderly so that a more true response of the participant toward the robot can be measured. This can be done through online data collection (the robot as subject of analysis but also as an active data collection tool). Another approach when investigating user responses to a robot over the logner term is to have a control group that is not exposed to a robot where the researcher visits just as frequent. If the control group also increases in mood and health then it is clear this is because of the visits by the researcher rather than the robot's activities. For the long-term experimentation we will take this learning into account by minimising the interaction between the participant and the researcher by carrying out the data collection through the robot as much as possible.

The robot that was presented as 'autonomous' (remote controlled but seemingly autonomous) was experienced by the elderly as a robot with limited use. Residents felt it would be a good tool to remind them of activities for instance or just to bring a quick message about something urgent. The telepresence robot which offered the caregiver or social worker on the screen was experienced as an extension of the caregiver. Elderly people overall felt it was quite similar to talk with the caregiver and could imagine themselves interacting with the caregiver in this way even though they would prefer a personal visit. In the Accompany project, our role is to look at robot roles and behaviours that are congruent to those roles. However, the trend we just described tells us that the positioning of the robot may be equally if not more, influenced by the extent to which the elderly person perceives the robot as an extension of the care-facilities he/she makes use of. For instance, we suspect that in case of recovery after stroke, when an elderly person has a robot at home temporarily from the carefacilities that support their re-enablement, the robot may be experienced as simply a tool or as an extension of the care facility. We think this may be stronger when the robot continues exercises and routines that were initiated during hospital stay or with caregivers. For the long-term experiments therefore, we consider carefully controlling for the participants perception of the robot as an extension of the care-facility or the university carrying out the study.

4 Design of long-term study

4.1 Abstract

This section describes the design of the first iteration of long-term studies that will be carried out as part of task T6.2 "Identify the factors that strongly influence long-term user acceptance" (see Section 4.5: Time plan). In this study we will assess the user responses toward a re-enablement robot over a long-term interval. It will consist in a study of the ethnographic type, with the participation of one elderly user and a robot that will stay in his/her home for the whole duration of the study. Data will be collected to reflect the evolution of the acceptance of the user's attitudes and responses toward the robot. Additionally, data will be also collected to verify the effectiveness of our chosen long-term study methodology.

4.2 Related Theory

4.2.1 Robots at home for prolonged periods of time

Numerous studies have been carried out on robots that shared the home space of the participants. A paradigmatic example, of a service robot in this case, is the Roomba: a highly autonomous vacuum cleaning robot. In several studies, Roomba robots were provided at households in order to study various aspects of the short-term and long-term interaction, e.g. [16], [17]. Sung et al. [16] found that after the participants had intereacted with the robot they valued it more than before, according to intelligence of operation, entertainment value, emotional attachment and overall impression. They found no significant increase in ease of use and usefulness for cleaning. Forlizzi et al. [17] carried out a longitudinal study where families lived with both a Roomba robot and a conventional vacuum cleaner. Roomba seemed to have a greater and more lasting effect on people than the conventional vacuum cleaner. The robot influenced cleaning activities according to gender, age and generation. For example, men and children took a more active role in cleaning. Sung et al. found that developing intimacy with the robot seems to improve happiness, increase lifelike associations and value it more [16].

Beside service robots, other studies have focused on home robots whose main function was that of a companion or entertainer. For example, Klamer et al. carried out a 10-days study with three elderly people and a Nabaztag robot, where participants evaluated several factors of the interaction with the robot, such as utilitarian, hedonic and social factors [18]. Even though disagreement was often found in their evaluations, endowing the dialogue robot with social intelligence seemed to yield positive results in the interaction with the human. Namely, it may contribute to a better perception of technology, an enhanced acceptance and an increased amount of social behaviors toward the robot, as found also in experiments with the iCat robot [19].

Few studies have been undertaken with a focus on robots to motivate the users in their own homes. In a study by Kidd and Breazeal [20] a robot had the role of a weight loss coach. Its effectiveness was measured and compared to the effects of using a computer or a paper log. The results showed that the participants used the robot for longer and had a closer alliance with it, although the differences in weight loss between the three systems were minimal.

4.2.2 Wellbeing and robots for re-enablement of elderly people

Not only physical causes, but also psychological and social factors determine the independence of elderly individuals. For example, some authors identified factors such as social pressure from others to apply for a place at a nursing home, loss of comfort and loss of affection as main predictors for considering elderly care residence [21]. Other authors showed evidence of the relevance of self-efficacy and coping in the wellbeing of elderly people [22]–[25]. In a first study we conducted, a contextual analysis of elderly people's daily life revealed insightful aspects about their interests, hopes and dreams, as well as their needs. A key finding in the study was that psychological distress appeared to be a major burden in the life of independent elderly [26]. These psychological aspects are important not only because of the distress they cause, but also because of their association with disability [26].

Particularly, low mood and depression seem to be relevant for the wellbeing of elderly people. Depression, defined as a persistent and pervasive low mood together with loss of pleasure in usual activities [27], seems to have a high prevalence among elderly people. About 3% have severe

depression and 10 to 15% suffer from mild to moderate depression [28], [29]. According to Steffens et al. [30], depression is one common cause of disability in elderly people. It has been shown to reduce life satisfaction, lead to loneliness, increase the use of medical services, reduce cognitive capacity, etc. As Arent et al. indicate in a meta-analysis [31], it seems that people older than 60 tend to show more mood disturbance (more negative affect and less positive affect). Thus, the application of treatments to improve mood and decrease depression in elderly people seem to be of high relevance.

Many studies have specifically focussed on robots to motivate older persons or alleviate their depressive symptoms. In a study by Fasola and Matarić [32], a socially assistive robot played with elderly people through a series of interactive activities. Its performance was compared across two conditions. In one condition the robot implemented behaviors that are known to improve one´s intrinsic motivation, such as praising the user upon completion of an exercise, providing reassurance in case of failing, showing humor or calling the participant by name. In the other condition, none of these features were included in the robot´s behavioral repertoire. Their results indicated strong user preferences of the motivating condition over the neutral condition.

A classical example of robots to improve elderly people's mood is Paro, the seal robot. In studies, Paro is typically brought to nursing homes where older people hold the robot and interact with it [15], [33], [34]. Paro´s benign appearance and pleasantness to touch facilitates the user´s attachment to the robot. It has often been used in nursing homes in long-term studies. Some of the reported positive effects of interacting with Paro are general improvement in feelings [15], [33], [34] and reduction in depression [15].

Thus far, robots should be considered as a valuable asset for the wellbeing of elderly people. The moral and social implications of this use of robotic technology are beyond the scope of the present report.

4.3 Problem Statement

For the current experiment we want to gain deep insight into the precesses, feelings and attitudes people experience when having an assistive robot at home for a prolongued period of time. In order to do so, we are inspired by the work of Wallace et al. [35] who more recently have used cultural probes as initiated by Gaver et al., e.g. [36]. In order to elicit responses in individual users [36] often the work is autobiographical or based on one-case examples. For our study also we choose to analyse in-depth one participant representitave of ACCOMPANY's target group, that is, an independent living elderly person. We feel this approach is needed to thoroughly understand a person's complex thoughts and emotions in order to design robots that will share the home space with their users for long periods of time.

Beside our choice of method, the use of our robot during a long period of time makes it very difficult to realize the study with several participants, given that the robot would stay at the home of the same participant during the whole long-term study.

In view of the above we arrived to the following **research questions**:

RQ1: how do the attitudes and responses toward a home assistive robot evolve over a long-period of time?

RQ2: how is a participant's daily life altered when an assistive robot stays in his/her home for a prolonged period of time?

RQ3: what will be the advantages and limitations of taking an ethnographic approach in a long-term HRI study where the appearance of the researcher will be kept to a minimum?

RQ4: can a home assistive robot be effective in providing psychological re-enablement?

4.4 Methodology

4.4.1 General design of the study

The research will be based on a study "in the wild" (at someone's home), whereby the participant will exercise with the robot on a daily basis. The data collection will be of the ethnographic type, performed through interviews and diary keeping following [37]. Our goal is to create explanatory theory on how the attitudes and responses toward a robot evolve over a prolonged period of time, for which the ethnographic data collection and grounded theory analysis will be employed as in previous similar studies [37], [38]. Additionally, quantitative measures will be taken of the acceptance toward the robot and effectiveness of the exercise.

4.4.2 Sample description

One elderly person will participate in the study. For the sake of confidentiality, the participant will be referred to as K. J., who is a male participant of age 79. K. J. lives alone in his home in a residential area of Enschede (the Netherlands). He used to live with his wife until she passed away 4 years ago. He spent his working life at the University of Twente on appointments related to policy making and administration. He does not receive any kind of elderly assistance. K. J. has not been diagnosed with any kind of dementia. Regarding familiarity with robots, he has seen robots on television but has almost no experience with them.

4.4.3 Robot set-up

As a meaningful exercise for re-enablement, the participant will practice a Heart Rate Variability (HRV) exercise with the robot. Heart rate variability (HRV) is the physiological phenomenon of variation in the time interval between heartbeats. It is measured by the variation in the beat-to-beat interval. Low HRV is associated, among others, with cardiovascular disease and high physiological arousal. High HRV is often employed as an indicator of general good health. Also, HRV is connected to psychological processes, such as emotion regulation, constructive coping and duration of worrying [39]. It is possible to train HRV through biofeedback techniques, which have proven to reduce stress and depression levels [40], [41]. These biofeedback exercises typically consist in synchronizing one's breathing with certain heart rate patterns that are measured through sensors and displayed on a computer screen or mobile phone [42]. Positive effects are found after practicing a few minutes a day for a duration of several weeks.

The whole study will have a duration of 4 weeks, during which the robot will stay uninterruptedly at the participant´s home. To be more precise, all interactions with the robot will take place in the living

room of the user. When it is time to practice the exercise the robot will move from its power docking station, situated in one corner of the living room, to a nearby shelf that contains in a box the HRV kit. Here, the robot will pick up the box using a hook attached to its arm gripper and will carry this to the user. The user will be waiting sitting on his/her couch and will receive the box when the robot arrives.

The robot has been designed to be similar in appearance and function to the Care-O-Bot 3 (see Figure 4). Technical features of the robot can be found at [43].

Figure 3: Robot prototype for the long-term study

Robot and user will communicate through a tablet (more details in Section 4.4.6: Procedure). This tablet will lie on a small table next to the user´s couch and will be continuously plugged to a power source.

For the whole duration of the study the participant will wear a wrist band that carries a skin conductance sensor (more details in Section 4.4.5: Measures).

4.4.5 Measures

Bodily measures:

Physiological arousal of the participant will be measured through a skin conductance sensor. High levels of skin conductance generally indicate a heightened arousal, which could be caused by stress or intense emotions (negative or positive). A wristband will be worn by the participant during the study, which contains among others a skin conductance sensor (Q Sensor) [44]. This device will provide also information about the participant's movement throughout the day and send data via Bluetooth to the tablet.

Qualitative measures:

The participant will make a new entry in a diary (see Appendix) every day. This diary will be of the type "**feedback diary**" as described by Lazar et al. [45]. The diary will contain open-ended questions such as "what worried you today?" and "what did you enjoy today the most?" in order to obtain data about their daily thoughts and emotions.

A **semi-structured interview** [46] with the participant will take place at the end of the long-term study (see Appendix). The interview will be video-recorded for later analysis. In addition, the participant will be provided with a photocamera, with which he will be encouraged to take pictures of the objects and situations that he will consider to have a special meaning to him throughout the day, such as situations that have been particularly enjoyable or unpleasant.

Questionnaires and scales:

Once a week, including the first and the last day of the study, the participant will complete the **Godspeed questionnaire** proposed by Bartneck et al. [47] to measure robot acceptance (see Appendix). This questionnaire is composed of 23 5-point semantic differential items, which are organized around the constructs Anthropomorphism, Animacy, Likeability, Perceived Intelligence and Perceived Safety.

The **Personal Opinion Survey** (POS) by McCraty et al. [40] will be used to assess stress levels and both positive and negative emotional states. This questionnaire is composed of 60 5-point semantic differential items (see Appendix). The stem for the questions of the questionnaire is: "Below are words that describe the way people sometimes feel. Please indicate how often you feel the following emotions by circling the appropriate number for each item." There are five possible answers, ranging from never (0) to always (4). Stress levels are determined by assessing two constructs: Anxiety and Stress Effects. Emotion is measured throughout the following constructs: Vigor, Happiness, Contentment, Caring, Depression, Guilt, Hostility, Burnout, Warmheartedness and Overcare. POS will be completed two times per week at the end of the day.

The items of both questionnaires will appear randomised every time the participant fills them in so as to reduce learning effects.

Finally, the frequency with which the participant uses the robot, as well as the duration of these episodes, will also be taken as a measure.

4.4.6 Procedure

Three meetings will be arranged with the participant before the start of the study (see Section 4.5: Time plan). In the first meeting, the participant will hear from the experimenter about the goals of the study, the details and the instructions. This will be formalized in a consent form, which will be handed in to the participant to be filled in. Here it will also be discussed what the preferable time for the daily exercise will be, as well as the place (couch or chair). Also, it will be decided where exactly the robot will operate (e.g. a specific route in the living room) and where the power docking station, HRV box and tablet will lie. Parts of the participant´s environment and the robot will be adapted for the study. The demographic information about the participant will also be recorded. In the second meeting, the participant will learn and practice the HRV exercise. In the third and last meeting, a drill of the whole

experimental setting will be carried out. The whole procedure will be enacted to ensure the participant understood the instructions and that all the equipment, especially the robot and tablet, work adequately. Also, a first interview (see Appendix) as well as the questionnaires will be administered (see Appendix). Finally, the times and dates to fill in the questionnaires and the diary and to realize the interview will be scheduled taking into account the participant's convenience.

When it is time for the exercise, the robot will localize the participant and bring him/her the HRV set so that the exercise can begin. During the duration of the study, the participant will carry a sensor to detect the user's level of arousal (a skin conductance sensor).

In addition to the daily scheduled HRV exercise, the robot will aid the user every additional time that the he/she asks the robot to aid him/her with the exercise (for example, if the person is worried and spontaneously decides to do the exercise at that moment). Also, the robot will proactively try to persuade the participant to carry out the HRV exercise whenever high stress levels have been detected, as inferred from the sensors worn by the user.

The communications through the tablet are the following. Every day, five minutes prior to the scheduled time for the exercise, the tablet will emit a sound to attract the user´s attention. When the user looks at the tablet, he/she will read the prompt "5 minutes to daily HRV exercise!" 5 minutes later, the tablet will sound again and prompt the message "Are you ready for the exercise?" Two action possibilities are always displayed on the tablet, one indicating "Start exercise" and another indicating "Postpone exercise". If the user presses "Start exercise", the robot will bring the HRV box to the user. If the user presses "Postpone exercise" or does not press any button the robot will wait for 15 minutes and communicate again through the tablet to remind about the exercise. If after this the user does not answer the tablet or presses "Postpone exercise" again, the daily exercise will be suspended for that day.

If outside the scheduled time for the exercise the user decides to do the exercise, he/she will sit on the couch and press the action possibility "Start exercise" on the tablet. The exercise will then be performed as in the daily procedure.

When the sensors detect a high heart rate in the user combined with a low level of movement, it will be assumed that the probability is high that the user is in a state of high anxiety. If this happens, the tablet will emit its sound to attract the user´s attention and will display the message "I have detected a fast rhythm, are you feeling alright? Please, press ´Start exercise´ if you would like to do the HRV exercise now. Press ´Postpone exercise´ if you do not want to do the exercise now."

An extra action possibility will always appear on the tablet: the "break-down button". If the participant presses this button, this will indicate that something went wrong in the study, for example that the robot stopped moving or did not operate in the expected way. Pressing the break-down button will send a signal to the experimenter, who will contact the user as soon as possible in order to solve the problem. For very urgent matters (e.g. situations that might threat the comfort of the user), a phone number is provided to immediately contact the experimenter. In addition, the phone number of an experimenter´s co-worker will be provided in case the experimenter could not be reached personally.

The last point of the study will consist in a debriefing meeting with the experimenter (see Section 4.5: Time plan). Here, also a participatory analysis will take place whereby the participant will go through the materials (videorecordings from interviews, diary and pictures from photocamera) to gain understanding of the user experience.

4.4.7 Analysis

The Godspeed and POS questionnaires will reveal if there was an evolution over time of the participant's attitides and responses toward the robot as well as whether the HRV exercise had indeed a healthy positive effect.

Following the methodology in [37], [38], the data collected through the interviews, the diary and the photocamera will be analysed employing a *grounded theory* analysis, a technique used to analyse qualitative data in which patterns are sought from the data (for further details, read [37]).

4.5 Time plan

2/01/2014: Meeting 1: Introduction of study to participant. Consent form is handed and personal information sheet filled in.

3/01/2014: Meeting 2: Training in HRV exercise.

4/01/2014: Meeting 3: Drill of the whole experimental setting. First interview. Questionnaires are filled in.

5/01/2014 – 31/01/2014: study is carried out at participant´s home.

3/02/2014: Meeting 4: Debriefing. Participatory analysis will take place.

1/02/2014 – 28/02/2014: data are analyzed and deliverable is elaborated.

28/02/2014: submission of first experimental iteration for D6.3.

Acknowledgments

We thank Sandra Bos, Agnes Deneka, Nestoras Foustanas, Marissa Hoek and Rieks op den Akker for their work at the study described in Section 3: Preliminary study.

We also thank Edwin Dertin and Takao Watanabe for their technical help with the robot for the long-term experiment.

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Appendix

Godspeed questionnaire:

Please rate your impression of the robot on these scales:

Fake	1	2	3	4	5	Natural
Machinelike	1	2	3	4	5	Humanlike
Unconscious	1	2	3	4	5	Conscious
Artificial	1	2	3	4	5	Lifelike
Moving rigidly	1	2	3	4	5	Moving elegantly
Dead	1	2	3	4	5	Alive
Stagnant	1	2	3	4	5	Lively
Mechanical	1	2	3	4	5	Organic
Inert	1	2	3	4	5	Interactive
Apathetic	1	2	3	4	5	Responsive
Dislike	1	2	3	4	5	Like
Unfriendly	1	2	3	4	5	Friendly
Unkind	1	2	3	4	5	Kind
Unpleasant	1	2	3	4	5	Pleasant
Awful	1	2	3	4	5	Nice
Incompetent	1	2	3	4	5	Competent
Ignorant	1	2	3	4	5	Knowledgeable
Irresponsible	1	2	3	4	5	Responsible
Unintelligent	1	2	3	4	5	Intelligent
Foolish	1	2	3	4	5	Sensible
Anxious	1	2	3	4	5	Relaxed
Agitated	1	2	3	4	5	Calm
Quiescent	1	2	3	4	5	Surprised

Personal Opinion Survey:

Below are words that describe the way people feel sometimes. Please indicate how often you feel the following emotions by circling the appropriate number for each item:

Anxious	1	2	3	4	5
Tense	1	2	3	4	5
Nervous	1	2	3	4	5
Afraid	1	2	3	4	5

Stress is hurting my work performance	1	2	3	4	5
I experience physical symptoms due to stress	1	2	3	4	5
Other people´s problems cause me stress	1	2	3	4	5

Excited	1	2	3	4	5
Energetic	1	2	3	4	5
Active	1	2	3	4	5
Vigorous	1	2	3	4	5
Lively	1	2	3	4	5

Happy	1	2	3	4	5
Glad	1	2	3	4	5
Cheerful	1	2	3	4	5
Delighted	1	2	3	4	5
Joyous	1	2	3	4	5

Calm	1	2	3	4	5
Pleased	1	2	3	4	5
Relaxed	1	2	3	4	5
Satisfied	1	2	3	4	5
Contented	1	2	3	4	5

Loving	1	2	3	4	5
Friendly	1	2	3	4	5
Affectionate	1	2	3	4	5
Warm	1	2	3	4	5
Passionate	1	2	3	4	5

Sad	1	2	3	4	5
Hopeless	1	2	3	4	5
Worthless	1	2	3	4	5
Miserable	1	2	3	4	5
Unhappy	1	2	3	4	5

Blameworthy	1	2	3	4	5

Guilty	1	2	3	4	5
Ashamed	1	2	3	4	5
Regretful	1	2	3	4	5
Remorseful	1	2	3	4	5
Angry	1	2	3	4	5
Irritable	1	2	3	4	5
Resentful	1	2	3	4	5
Enraged	1	2	3	4	5
Bitter	1	2	3	4	5
Used up	1	2	3	4	5
Burned out	1	2	3	4	5
Fatigued	1	2	3	4	5
Exhausted	1	2	3	4	5

End of my rope	1	2	3	4	5
Represented by kindness	1	2	3	4	5
Represented by Appreciation	1	2	3	4	5
Represented by Love	1	2	3	4	5
Represented by Care	1	2	3	4	5
Represented by Tolerance	1	2	3	4	5
Represented by Forgiveness	1	2	3	4	5
Represented by Acceptance	1	2	3	4	5
Represented by Harmony	1	2	3	4	5
Represented by Compassion	1	2	3	4	5

Over-critical	1	2	3	4	5
Over-sympathetic	1	2	3	4	5
Over-responsible	1	2	3	4	5
Self-pitying	1	2	3	4	5

First Interview

Introduction

The interviewer introduces himself by saying *hello, it´s very nice to see you again, how are you?*

Interviewer thanks the interviewee again for the participation. If there are other people in the scene, these are mentioned and thanked: *and thank you also to you* (3rd person in the scene) *for your help. It is alright that you are here while we conduct the interview.*

The purpose of the interview is explained. *As we explained to you already the other day (*in the first meeting with participant*) I would like to learn more about you and your life at home. This information will be needed to understand the impact that the robot will have on your daily life.*

It is common practice to audio or video record interviews. If you do not mind, I would like to video record this interview. This will allow me to go back in time to review your comments so that I do not become distracted by taking notes.

Video camera and audio recorder are prepared and start recording at this early stage, since interviewees may start to provide valuable information even before the first questions.

All the information derived from this interview will be treated confidentially. There are no right or wrong answers. It is important for my research to receive honest opinions. If you do not have an opinion about a topic or prefer to omit an answer, you are not obliged to answer. You are allowed to leave at any time or to interrupt the interview. Please let me know whenever you have a question.

Interviewer prepares his copy of this protocol with interview questions.

Body of the interview

Open questions are asked first. Specific questions are asked if detailed information has not been provided.

Questions that could cause embarrassment or resistance are preceded by a version of the following cue:

It may be a little embarrassing/personal for you, but I need this information. Remember all data is treated confidentially.

The purpose of these questions is to make the interviewee start talking about anything they want. The intention is to find priorities in interviewee and to start to create a positive rapport (very easy, open-ended questions). Finish after 5 min.

How are you doing recently?

How is everything going?

And your family?

A) Questions on daily life, habits and health

A good way of knowing about the daily life of a person is to ask about a recent day in particular. Try to re-enact in your mind the things you did yesterday. Could you describe, step by step, the activities that you performed?Try to describe also the little activities that you might take for granted.

It is very likely that after the participant´s answer there will still be activities and aspects of the participant´s daily life that have not been discussed. The interviewer will check the following list and further ask about activities that were not addressed. In this case, the interviewer will start for each topic with *you might have forgotten about (*activity*). Could you please tell me more about this?*

List of common daily activities:

Wake-up

Toileting/bathing

Preparation and consumption of breakfast

Cooking

Eating lunch

Resting during the day

Sleep at night

Cleaning

Vacuuming/sweeping

Mopping

Dust

Windows

Kitchen

Dishes

Bedroom

Bathroom

Tidying house

Garbage management/taking out garbage

Examples: separate/recycle, take out garbage.

Laundry (washing and drying)

Make bed

Ironing

Making and repairing clothes

Maintaining dwelling and furnishings

Maintaining domestic appliances and other machines

Example: *What do you do when a domestic appliance breaks?*

(When applicable) Maintaining assistive devices

Maintaining vehicles

(When applicable) Taking care of plants and gardening:

Examples: *water plants, garden, manure, cut lawn.*

(When applicable) Taking care of animals:

Examples: *feed pets, walk the dog.*

Get mail, newspaper.

Shopping and acquiring goods and services

Examples: *buy groceries and other home products, unpacking them, storing them.*

Administrative issues

Bank

Pension

Insurance

Use of technology

Telephone

Watching TV

Music

Computer, Internet, emails

Social life

Family

Partner

Parents

Siblings

Other relatives

Friends

Informal and formal associations

Neighbors, acquaintances, etc.

Recreation

Do you perform religious activities?

How do you find entertainment?

Tell me more about your hobbies.

Do you practice any sport?

So far we have discussed your routines on a typical day. Do you have days when you do different things?

If nothing comes to mind, examples are offered: villa, Sundays, holidays.

B) Questions on psychological health, stress and depression

As I already explained to you in our introductory meeting, you will perform an activity with the robot which will help you reduce your stress levels and improve your mood. Therefore, it is important for us to know at which point we are starting now. I remind you this conversation is confidential, but you do not need to give an answer if you are not comfortable with that.

Are you currently feeling especially nervous or worried?

Why?

What do you do when you are nervous or worried?

How is your mood on the last few days?

Why?

What do you do when you are nervous or worried?

C) Questions about expectations on robot

How familiar are you with robots?

Do you think this robot will really help you?

How?

Do you think there will be a change in your daily life?

And in your mood and stress?

And in the way how you perceive the robot?

End of interview

Interviewer tells interviewee that the interview is finished and asks if there are additional comments or questions.

Interviewee is thanked again.

Interviewing material is collected.

Second interview

Introduction

The interviewer introduces himself by saying *hello, it´s very nice to see you again, how are you?*

Interviewer thanks the interviewee again for the participation. If there are other people in the scene, these are mentioned and thanked: *and thank you also to you* (3rd person in the scene) *for your help. Again, it is alright that you are here while we conduct the interview.*

The purpose of the interview is explained. *As we explained to you already in the last meeting before the study, in this interview I would like to learn how the robot changed aspects about yourself and regaring your daily life.*

As I mentioned in the first interview, it is common practice to audio or video record interviews. If you do not mind, I would like to video record this interview. This will allow me to go back in time to review your comments so that I do not become distracted by taking notes.

Video camera and audio recorder are prepared and start recording at this early stage, since interviewees may start to provide valuable information even before the first questions.

Also, I will repeat again that all the information derived from this interview will be treated confidentially. There are no right or wrong answers. It is important for my research to receive honest opinions. If you do not have an opinion about a topic or prefer to omit an answer, you are not obliged to answer. You are allowed to leave at any time or to interrupt the interview. Please let me know whenever you have a question.

Interviewer prepares his copy of this protocol with interview questions.

Body of the interview

A) Questions about the experience in general

Questions about the experience in general:

Before we narrow down to details, please tell me in your own words how the overall experience was.

Did you enjoy the experience?

What did you like the most?

What would you change?

B) Questions about acceptance of the robot

What do you think about the robot?

Do you like the robot?

Was interacting with robot interesting or boring?

Why?

How would you improve the interaction with the robot?

C) Questions about changes in daily life

How was your daily life different compared to before the study?

The interviewer checks the list in the first interview about common aspects of daily life and asks accordingly when the participant did not address an activity.

D) Questions about mental life and the HRV exercise

After all these days, what do you think about the HRV exercise?

Was it easy to use?

Did you enjoy the exercise?

Are you thinking of continuing the exercise after the study?

Do you think it worked?

Are you feeling more or less stress than before?

Are you feeling happier or sadder than before?

What other changes did you experience due to the exercise?

Were there changes in your emotions?

Were there changes in your stress levels?

What would you do to improve the exercise and its use?

What would you do otherwise to reduce your stress?

And to improve your mood?

End of the interview

Interviewer tells interviewee that the interview is finished and asks if there are additional comments or questions.

Interviewee is thanked again.

Interviewing material is collected.